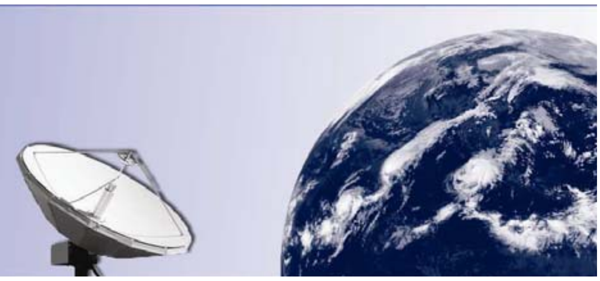
EMPRES WATCH

emergency prevention systems



Possible RVF activity in the Horn of Africa

1. Introduction

Rift Valley fever (RVF) is an arthropod-borne viral disease of ruminants, camels and humans. It is a significant zoonosis which may present itself from an uncomplicated influenza-like illness to a haemorrhagic disease with severe liver involvement and ocular or neurological lesions. In animals, RVF may be unapparent in non-pregnant adults, but outbreaks are characterised by the onset of abortions and high neonatal mortality. Transmission to humans may occur through close contact with infected material (slaughtering or manipulation of runts), but the virus (Phlebovirus) is transmitted in animals by various arthropods including 6 mosquito genus (*Aedes, Culex, Mansonia, Anopheles, Coquillettidia* and *Eretmapodites*) with more than 30 species of mosquitoes recorded as infected and some of them been proved to have a role as vectors. Most of these species get the infection by biting infected vertebrates, yet some of these (specifically *Aedes* species) transmit the virus to their eggs. These infected pools of eggs can survive through desiccation during months or years and restart the transmission after flooding, and then other species (*Culex* spp.) may be involved as secondary vectors.

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This vertical infection explains how the disease can persist between outbreaks.

RVF virus (RVFV) is recorded to occur from South Africa to Saudi Arabia including Madagascar, in varied bioclimatic ecotypes, ranging from wet and tropical countries such as the Gambia, irrigated regions such as the Senegal River Valley or the Nile Delta, to hot and arid areas such as Yemen or Chad. The occurrence of RVF can be endemic or epidemic, depending on the climatic and vegetation characteristics of different geographic regions. In the high rainfall forest zones in coastal and central African areas it is reported to occur in endemic cycles which are poorly understood. Currently available evidence suggests that this may happen annually after heavy rainfall, but at least every 2-3 years otherwise. In contrast, in the epidemic areas in East Africa, RVF epidemics appear at 5 to 15 year cycles. These areas are generally relatively high rainfall plateau grasslands, which may be natural or cleared from forests. In the much drier bushed Savannah grasslands and semi-arid zones, which are characteristic for the Horn of Africa, epidemic RVF has manifested itself only a few times in the past 40 years, in 1961-62, 1982-83, 1989 and in 1997-1998.

In addition the possibility exists that RVFV may spread outside traditionally endemic areas, or even out of the continent of Africa, mostly due to the large range of vectors capable of transmitting the virus and requires a level of viraemia in ruminants and humans that is sufficiently high to infect mosquitoes. Such a situation occurred following the unusual floods of 1997-1998 in the Horn of Africa countries, and subsequently the disease spread to the Arabian Peninsula in 2000.

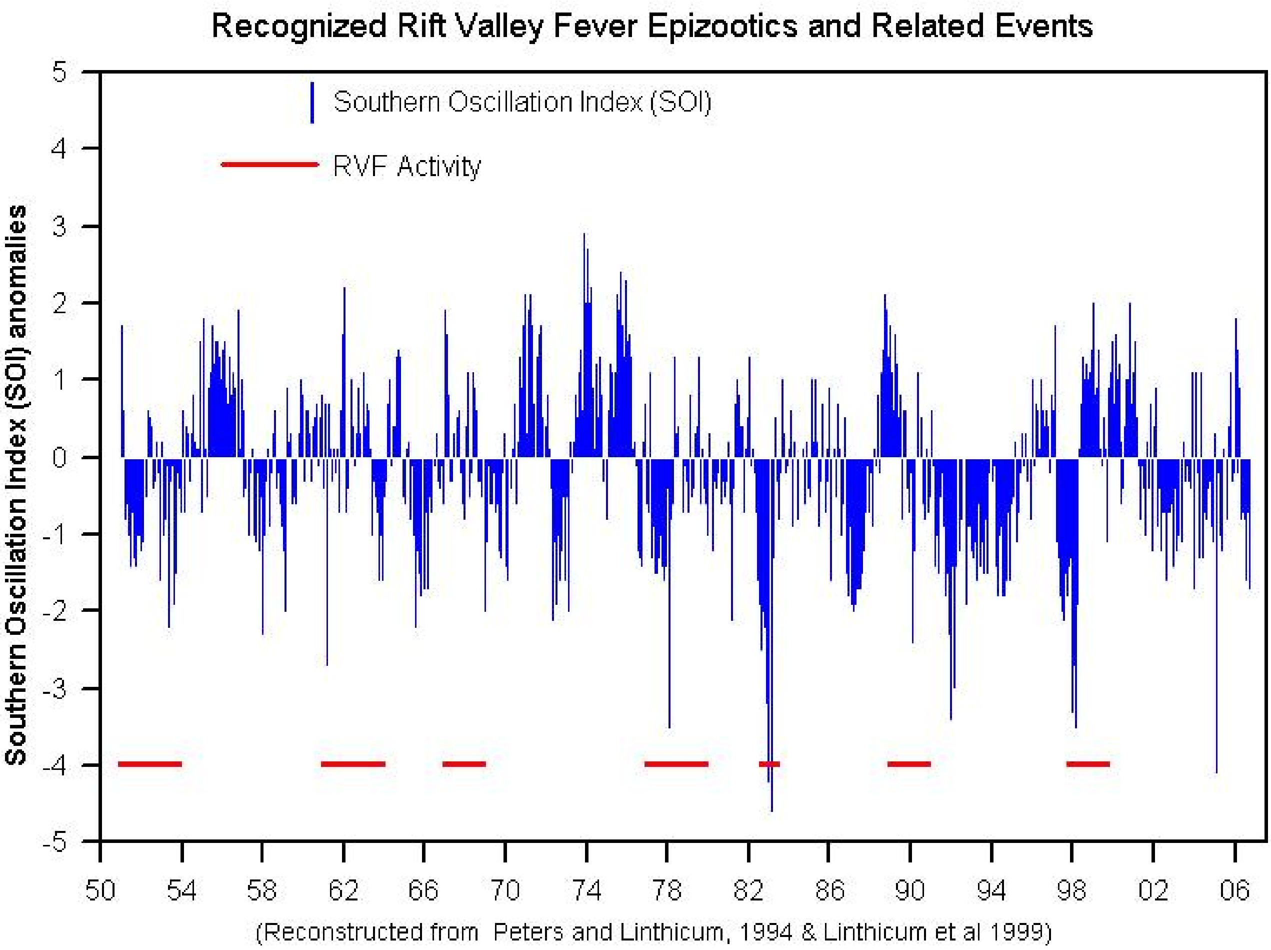
2. Disease ecology and climatic drivers in the horn of Africa

The ecology of RVF has been intensively explored in East Africa. Historical information has shown that pronounced periods of RVF virus activity in Africa have occurred during periods of heavy, widespread and persistent rainfall now associated with *El Niño* events. As an example, the outbreak of December 1997 in Kenya followed 60 -100 times above average rainfall. The outbreak then rapidly spread to Somalia and Tanzania, with human cases estimated at 89 000.

Incriminated vectors were floodwater *Aedes* species whose breeding habitats are known as *dambos* in Kenya, which are temporary ground pools in the fringe of main rivers. Periods of persistent rainfall raise the ground water table to a level where the breeding sites of *Aedes* become flooded and the eggs regain their moisture. Eggs harbouring the RVF virus will hatch in great number and finally female adults can transmit the virus to susceptible hosts during blood meals.

Widespread rainfall in the region is caused by the changing characteristic of the Intertropical Convergence Zone, the zone of confluence of air currents from north and south in the African continent, as a consequence of *El Niño* events triggered by large scale changes in sea surface temperature in the Pacific and Indian Oceans.

FIGURE 1
Time Series plots of the Southern Oscillation Index (SOI) and coincident RVF activity: 1950-2006



Periods of RVF activity in Kenya (depicted by red bars) plotted against the Southern Oscillation Index (SOI) from 1950 to 2006.
RVF outbreaks have tendered to occur during the negative phase of the SOI, associated with El Nino events.
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Vegetation responds to increased rainfall and variation can be easily measured by satellite. In East Africa, vegetation index maps have been used together with ground data in monitoring vector populations and RVF viral activity, which established a correlation between these two parameters. In a more prospective way, vegetation measurements can be used to forecast RVF before it reaches epidemic proportions. Data sets used in these predictions include satellite outputs, mainly from the Advanced Very High Resolution Radiometer sensor (AVHRR) on-board polar-orbiting satellites operated by the National Oceanographic and Atmospheric Administration (NOAA of the USA), which are used to generate various indices including vegetation index (NDVI) or Cold Cloud Duration (CCD) which are correlated with rainfall. Predictive models have been greatly improved by the addition of Pacific and Indian Ocean Sea Surface Temperature anomaly measurements, together with the rainfall and NDVI data. An accuracy of 95-100% was estimated for the prediction of Kenyan epidemics of RVF, with a lead time of 2 to 5 months.

3. Monitoring of climatic indicators

At FAO headquarters, near real-time climatic data such as rainfall estimates and NDVI indices obtained from Artemis[1] are collected and processed using the FAO developed Windisp 3.0 software. Risk maps are produced by calculating vegetation index and rainfall anomalies comparing current conditions to long-term mean conditions. Resulting maps show areas experiencing above normal rainfall.

A major partner institution is the NASA Goddard Space Flight Center (USA) which produces RVF monthly risk maps based on the persistence of Vegetation index (NDVI) anomalies. Vegetation index data derived AVHRR and SPOT Vegetation are used to monitor ecological conditions and dynamics through time.

1 In order to assist these programmes, FAO established in 1988 the Africa Real Time Environmental Monitoring System (ARTEMIS), with the objective of providing a routine flow of satellite imagery in near real-time indicating the status of the growing season and vegetation development over Africa

4. Recent warning message

The NASA Goddard Space Flight Center has been monitoring climate conditions in the East of Africa for the past several years and has delivered to FAO a warning message on risk occurrence of vector-borne diseases and more specifically RVF, if the situation remains the same in the coming weeks. In some locations, the current rainfall estimates are similar to what was observed in 1997/98, when a major outbreak occurred in Tanzania, Somalia and Kenya. This situation is linked to an anomalous increase in sea surface temperatures in Central and Eastern Pacific Ocean and similarly in the Western Indian Ocean region (about 0.5°C) in September 2006. Accordingly, the Southern Oscillation Index (SOI) continues to show persistent negative values over the last six months, indicating the development of *El Niño* event. The convergence of all these conditions has resulted in increased and widespread rainfall over the last three months over most of Eastern and coastal Kenya, Somalia and Southern Ethiopia. Some of these areas have received as much as 200mm above normal rainfall in October and November 2006.

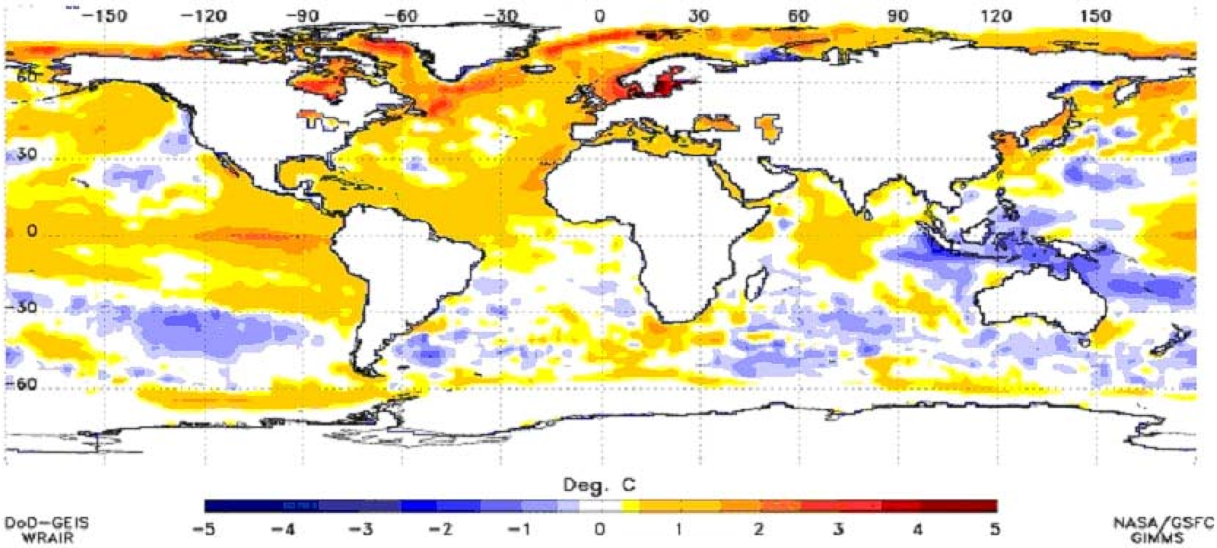
As a consequence, green vegetation growth in these areas is up by 40 – 60% compared to the expected situation. In October, the Southern Oscillation Index (SOI) continues to show persistent negative values over the last six months, indicating the continued development of *El Niño* event.

Positive NDVI anomalies were recorded over most of the continent in October 2006 with the largest departures concentrated over Southwest Africa and over East Africa especially Eastern Kenya and Somalia which show an above normal rainfall in September and October. Data in November confirm this increased vegetation activity.

Procedures for processing RVF risk maps from NDVI anomaly data were validated in previous studies conducted in East Africa. Thresholds reached in the magnitude and persistence of the anomalies were associated with anomalous widespread and prolonged rainfall events and RVF outbreaks. As shown in the resulting map, there is elevated risk of RVF activity over the continent for November 2006 in Northern Senegal/Southern Mauritania region, Northern Kenya, Somalia, Botswana and Namibia. Given the enhancement of the current El Niño conditions in the Pacific and associated warming in the West Indian Ocean region, above normal rainfall is likely to persist in the RVF endemic areas of East Africa thus elevating the risk of RVF activity in the region over the next 4-6 months. These are the areas that will require ground surveillance and response to disease outbreaks during the next 2-6 months.

FIGURE 2

Sea Surface Temperature Anomalies in October 2006



The Western Indian Ocean region shows continued development of positive SST anomalies coincident with the warming in the eastern equatorial Pacific Ocean from 90W to 150W which shows a pattern that is typical of ENSO-warm conditions with maximum warming so far between +1.0 to +2.0 ºC. Enhanced negative SST anomalies in the western Pacific-Indonesian region confirm that El Niño conditions are very much underway.

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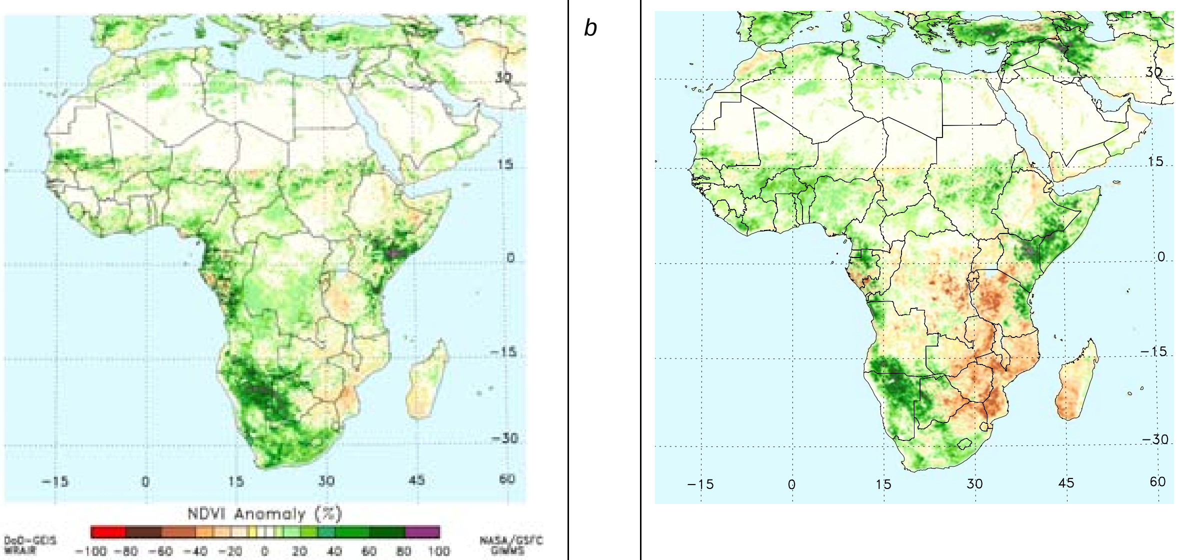
FIGURE 3

NDVI anomalies in (a) October and (b) November 2006

a *b*



NDVI anomalies during October (a) and November (b) 2006, showing elevated vegetation conditions in East Africa (+60 - +80 %) and south western Africa associated with above normal rainfall during the last three months.

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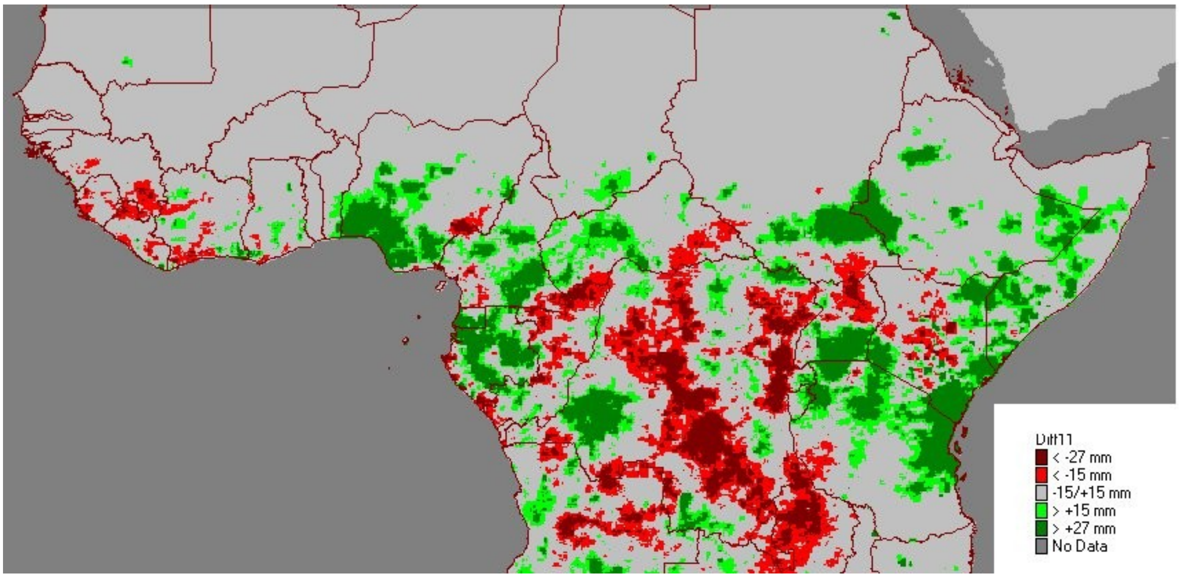
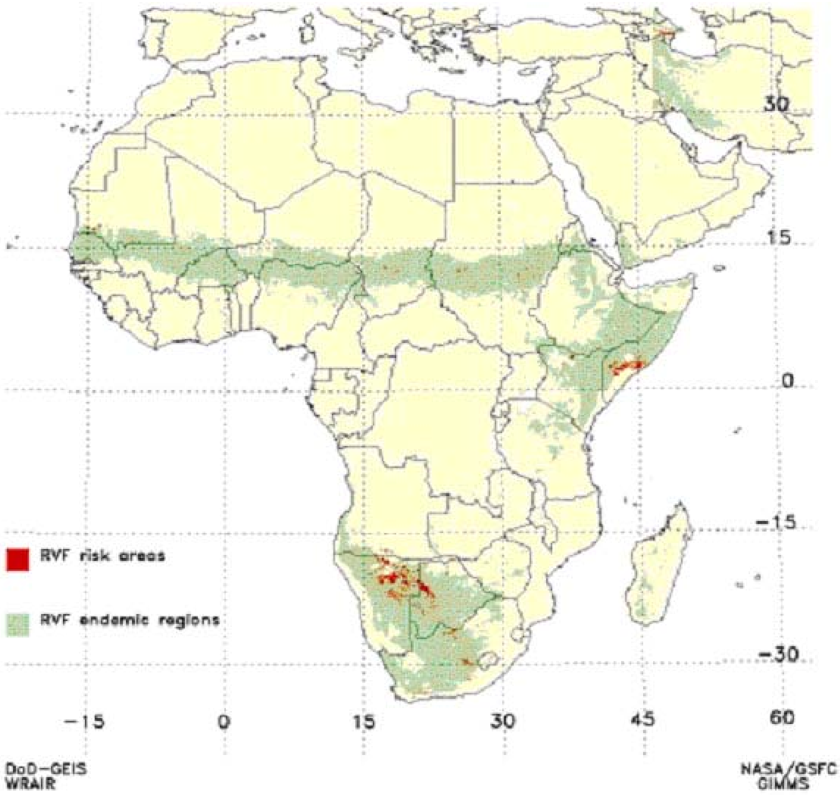
FIGURE 4
Rainfall anomalies during the first decade of November 2006



Data extracted from respectively Meteosat and Spot Vegetation, compiled with ARTEMIS (Africa Real Time Environmental Monitoring System, FAO).

FIGURE 5
Rift Valley Risk map in November 2006



Areas shown in red colour indicate areas at risk to RVF activity, those shown in green are those within an RVF endemic region or in areas where RVF virus has been identified, those shown in yellow have no risk
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5. Recommendations

The Risk maps presented in this review were obtained from the analysis of environmental data alerts and depict specific areas of Africa that could face new outbreaks of vector-borne diseases and more specifically Rift Valley fever. Countries located in high risk areas of RVF and those which recently experienced RVF should activate and increase disease surveillance according to OIE standards in particular those countries located in areas associated with the previous occurrence of RVF. If there are no reports of clinical signs compatible with RVF, disease surveillance should focus on mosquitoes and serology of susceptible ruminants only. FAO encourages these countries to activate their early warning, prevention and contingency plans.

Importing countries of meat or animals from RVF risk areas should not apply trade restrictions if disease surveillance is in place in countries/zones at risk with negative results. The OIE standards clearly separate “RVF infection free country or zone” from “RVF infected countries/zones without disease”. In the first case the country is out of the historical distribution area, a surveillance programme is in place and 4 years have elapsed since the last epidemic. In the second, the country is considered free but disease has not occurred in humans and animals in the past 6 months and climatic changes predisposing to outbreaks of RVF have not occurred during this time. A third classification is “RVF infected country/zone with disease”, meaning clinical disease in humans and animals has occurred within the past 6 months. Even in presence of disease or infection, the OIE Terrestrial Animal Health Code accepts trade of ruminants and meat from infected countries if certain specific conditions of quarantine or vaccination are met. This is based on timely and prompt notification of infection or disease to the OIE.

6. FAO in action

1. The EMPRES (Emergency Prevention System for the Transboundary Animal Diseases) programme provides, at an international level, an overall initiative for coordination of the RVF-Early Warning System, where data integration and analysis are performed before being disseminated to recipient countries, international organizations and key stakeholders in the form of RVF bulletins and risk assessments. EMPRES promotes the use of remote sensing for forecasting RVF and other arboviruses occurrence and field validation studies on a country and regional basis, and its use may allow for preventive measures to be taken such as the vaccination of susceptible livestock and mosquito larval control methods.

2. The regional taskforces in Kenya have been alerted. FAO office in Kenya is currently monitoring the situation and is promoting field assessment mission in flooded areas. Results are expected in the near future.

7. For more information

Analyses and products provided by the Rift Fever Monitoring Group: Assaf Anyamba (UMBC/GEST-NASA/GSFC), Jennifer Small (SSAI-NASA/GSFC), Compton J. Tucker (NASA/GSFC), Kenneth J. Linthicum (USDA/CMAVE) and Jean-Paul Chretien (DoD-GEIS). This work is in part supported by the Department of Defense Global Emerging Infections Surveillance & Response System (DoD-GEIS), Walter Reed Army Institute of Research.
Website:
http://www.geis.fhp.osd.mil/GEIS/SurveillanceActivities/RVFWeb/indexRVF.asp

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